

## VOLUME DATA NET BACKUP

### BACKGROUND OF THE INVENTION

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#### Technical Field

This invention relates to data backup in computer systems, and more specifically to a method of transferring data across a network.

#### Description Of The Prior Art

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Networked computer systems with interconnected nodes are an increasingly popular alternative computer architecture to more traditional computer architectures. A networked system may be a collection of individual computers known as nodes that are interconnected to provide a single computing system. Fig. 1 is an illustration of the layers of a node in a typical network environment. Each system node 10 in a networked computing environment includes a form of a physical storage device for storing data and generally may include multiple storage devices 12, 14. Traditionally, the storage devices will be in the form of a disk or tape. The storage devices 12, 14 are logically grouped into a volume 26 through the use of plexes 16 and 18. The volume 26 and plexes 16 and 18 are all maintained within a volume manager 28. The system 10 also has a network device 22 for communicating over the network with other nodes in the system. Accordingly, each node in the network includes physical storage devices for storing node data, plexes for communicating data in the storage devices to a volume which logically maps the data, and a network device for communicating across the network with other nodes in the system.

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In a typical computer network environment, each node includes several layers in a program stack. A traditional model of a network environment for a two node system is shown in Fig. 2. Each node 110 and 130 has a physical devices layer 112, 132, respectively, where data storage devices 114, 116 and 134, 136, and network adapters 126, 146 are located. In addition to the physical devices layer 112, 132, each node includes a kernel layer 115, 135 and a user layer 120, 140, respectively. The user layer 120, 140 is the area where

application programs 122, 142 are accessed. The kernel layer 115, 135 contains a volume manager layer 128, 148. The volume manager layer 128, 148 manages the flow of data in the storage devices to and from the application program 122, 142 in the user layer 120, 140, respectively. Accordingly, the program stack includes three primary layers for operating each node in the network.

The process of backing up data in a traditional two node network involves the following steps:

1. Data is copied from the physical devices layer 112 to the volume manager layer 128 of the kernel layer 115 of the source node 110;
2. Next, the data is copied from the volume manager layer 128 to the application program 122 in the user layer 120;
3. Data is then copied from the application program 122 in the user layer 120 through the kernel layer 115 to a network device 126;
4. The data is then copied from the network device 126 of the source node 110 across a communication pipe 150 to a network device 146 of the target node 130;
5. The data is then copied from the network device 146 through the kernel layer 135 to the application program 142 of the user layer 140;
6. Next, the data is copied from the application program 142 in the user layer 140 to the volume manager layer 148 in the kernel layer 135; and
7. Finally, the data is copied from the volume manager layer 148 of the kernel layer 135 of the target node 130 to the physical layer 132.

Accordingly, the traditional data backup method requires communication of the data through multiple layers of the program stack, including the user layer.

The disadvantage of this procedure is that there are multiple copies of data transferred from the kernel to the user layer and from the user layer to the kernel layer. This conventional method of backing up data on a storage device connected to some other

machine on the network requires a series of copying, and is therefore inefficient due to the multiple copies of data involved. Accordingly, there is a need for an efficient method of backing up data on a computer system which is one of multiple nodes in a network, wherein multiple copies of the data need not be processed through the user layer of the nodes in the system.

## SUMMARY OF THE INVENTION

It is therefore an object of the invention to provide a method of efficiently backing up and restoring data of a networked computer system. It is a further object of the invention to provide a storage device manager for use in networked computer systems for allowing internode data transfer through a kernel layer of the operating system.

A first aspect of the invention is a method for storing data from a network on a node. A first plex is connected to a network device, and a second plex is connected to a data storage device. Both plexes are grouped into a logical volume. Data is received from the network by the first plex and stored on the storage device by the second plex.

A second aspect of the invention is a networked computer system. Each node in the system includes a data storage device, and first and second plexes. The first plex is connected to a network device and the second plex is connected to the data storage device. A volume is connected to both the first and second plexes for logically mapping the data from the plexes.

A third aspect of the invention is an article comprising a computer-readable signal bearing medium with means for communicating to a networked computer system. The article includes two plexes. A first plex is connected to the communication means and the second plex is connected to a data storage device. Both the first and second plexes are connected to the volume. The article also includes means in the medium for managing the transfer of data.

Other features and advantages of this invention will become apparent from the following detailed description of the presently preferred embodiment of the invention, taken in conjunction with the accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of a prior art computer system with mirrored data;

FIG. 2 is a block diagram of a prior art internode method of backing up data;

FIG. 3 is a block diagram of internode backup of data according to the preferred embodiment of this invention, and is suggested for printing on the first page of the issued patent; and

FIG. 4 is a block diagram of internode restoration of data according to the preferred embodiment.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

### Overview

Minimizing the quantity of copies of data produced in a backup of a storage device of a node in a computer network is essential for improving operating efficiency. Each node stores data in a logical volume which maps the data from a single or multiple storage devices through the use of a mirror, also known as a plex. Data from the logical volume of one node may be transferred to another logical volume of another node, *i.e.* target node, with the use of a mirror also known as a plex and a network adapter. Accordingly, data can be replicated across the mirrors of the volumes resident in separate nodes of a networked computer system.

### Technical Background

As illustrated in Fig. 1, each node 10 in a computer network is broken down into several layers of program operation. The user layer 6 of the program operation includes the application program 4. The physical layer 8 contains apparatus such as data storage devices 12, 14 for storing node data, and a network adapter 22 for physically connecting the node to other nodes in the network. The physical storage devices 12 and 14 read and write data associated with that particular node. The kernel layer 20 of the program operation contains

plexes 16 and 18, and a volume 26. Both the plexes 16 and 18 and the volume 26 are maintained within a volume manager 28. The term plexes is synonymous with the term mirror. The volume 26 logically maps the data from the storage devices 12 and 14 through multiple mirrors 16 and 18. The mirrors 16 and 18 function to give redundant access to data in the particular volume 26. Writing to the volume 26 writes to all of the mirrors in the volume, and reading from the volume 26 uses one of the mirrors. Accordingly, for the purposes of this invention, a node 10 is an individual computer of a network having mirrored data.

Fig. 3 is an illustration of the preferred embodiment of the invention showing how two nodes on a network may be configured to back up data on a target node 70 in the network. In this illustration, node 50 is the source node and sends data to the target node 70, where the data is backed up. The data essentially travels from the volume manager 65 of the source node 50 to the network adapter 52 of the source node 50, across to the network adapter 72 of the target node 70 and to the volume manager 85 of the target node 70. Both the volume manager 65, 85 and the network adapters 52, 72 of the nodes 50, 70, respectively, operate outside of the user layer of the operating system. Accordingly, the model illustrated in Fig. 3 allows for internode communication of data from a kernel layer of a source node 50 directly to a kernel layer of a target node 70.

As shown in Fig. 3, the source node 50 includes a volume manager 65 within the kernel layer 66. The volume manager has two volumes 54 and 64, and three mirrors, also known as plexes 56, 58 and 68. Volume 64 communicates with plex 68 and storage device 67, and volume 54 communicates with plex 58 and plex 56. Plex 58 communicates with storage device 60 in the physical layer 69, and with the volume 54 in the volume manager 65. Plex 56 communicates with the volume 54 in the volume manager 65 and with the network adapter 52 in the physical layer 69. The volume 54 is a logical mapping of at least some of the physical devices in the node 50. Since node 50 is indicated as a source node for sending data to a target node for backup, volume 54 is configured to receive data from any plex in the node other than plex 56. Furthermore, plex 56 is technically a receiving plex in that it is configured to receive data from the volume 54 and to send the received data to the network

adapter 52. Accordingly, the node structure of the source node 50 is configured to feed data to a target node in the networked computer system for backing up the data of the source node.

The target node 70 is similarly configured to the source node 50. A volume manager layer 85 is located within the kernel layer 86. The volume manager 85 has one volume 74, and two mirrors, also known as plexes 76 and 78. Plex 78 communicates with storage device 80 in the physical layer 89 and with the volume 74. Plex 76 communicates with the volume 74 and the network adapter 72. The volume 74 is a feed volume which is a logical grouping of physical devices and directs data to each of the plexes in the volume that communicate with the volume 74. Plex 76 is also known as a feed plex which acts a communication pipe for receiving data from a network adapter 72 and transferring the received data to the feed volume 74 of its associated node 70. Accordingly, the node structure of the target node is configured to receive and store data received from a source node in the networked computer system.

As shown in Fig. 3, the source node 50 is configured with a network adapter 52 in communication with one of the plexes 56 of the node 50, and the target node 70 is configured with a network adapter 72, a feed plex 76 and a feed volume 74. By configuring plex 76 to be a feed plex, data can be sent to the target node 70 from any plex in any source node 50 which has a plex in communication with the network adapter 52. The feed plex 76 is a communication pipe for receiving data. When the data is transferred from the source node 50 to the target node 70 across the network adapter, the data is received by the feedplex 76 communicating with the network adapter 72. The feed plex 76 then feeds the data received by the feed plex 76 from the source node 50 to the feed volume 74 of the target node 70. The feed volume 74 then directs the received data from the source node 50 to all other plexes in that volume. Accordingly, the connection of the plex 56 to the network adapter in the source node, and the connection of the feed plex 76 to the network adapter 72 of the target node allows backup of data in a network environment across the kernel layers of the nodes without requiring generation of multiple copies of data through the user layer of either the source or target nodes.

Fig. 4 shows data being restored from a previous target node 70 onto a prior source node 50. The target node 70 is similarly configured to the target node illustrated in Fig. 3. However, plex 78 is now designated as a feed plex for communicating data from the storage device 80 to the feed volume 74. In addition, the feed plex 76 is now designated as a plex for communicating data from the feed volume 74 to the network adapter 72, plex 56 of the source node 50 is now designated as a feed plex for transferring data received from the network adapter 52 to the volume 54, and volume 54 is now designated as a feed volume. The feed plex 78 transfers previously backed up data on the storage device 80 to the feed volume 74, which transfers the data to the network adapter 72 through the plex 76. The network adapter 72 sends the previously backed up data to the network adapter 52 of the source node 50. The data received from the network adapter 52 is transferred to the feed volume 54 through the feed plex 56. The feed volume 54 then directs the received data from the target node 70 to all plexes in that volume. Accordingly, the connection of the plexes 56, 76 with the network adapters 52, 72 provides a structure for allowing restoration of data that was previously backed up on a target node across the kernel layers of the nodes, without requiring multiple copies of the data to be processed through the user layers of either operating system.

### Advantages Over The Prior Art

The use of a feed plex and a feed volume transfers data across a network adapter between network nodes through the kernel layers of the target and source nodes. It permits easy backup and restoration of data using the same plex management tools normally used by system administrators to manage physical storage devices and logical data volumes. The use of the feed plex and feed volume configurations does a full backup and/or restoration of data residing in any node of the network. Furthermore, these data transfer tools allow data to be communicated between nodes at the kernel level of the operating system. This avoids copying of the data through the user layers of the operating system. Accordingly, the method

and system for internode data communication avoids duplication of data at multiple layers of the system and thereby increases efficiency in data backup and restoration.

### Alternative Embodiments

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It will be appreciated that, although specific embodiments of the invention have been described herein for purposes of illustration, various modifications may be made without departing from the spirit and scope of the invention. In particular, the feed plex may be connected to a network adapter. This enables the feed plex to transfer data arriving through the network connection to the feed volume. The connection of the feed plex to the network adapter is a preferable configuration for backups. Alternatively, the feed plex may be connected to a backup device in which case it feeds the data from the backup device to the feed volume. This method is optimal for data restoration. In addition, the scope of the invention should not be limited to a two node system nor to a node with a minimal quantity of plexes. Each volume within a node may have multiple plexes for reading and writing data to and from the associated volume. The invention may be implemented in a multiple node system incorporating the network adapter connection for the source and target nodes in conjunction with a feed plex and a feed volume for the respective node. Accordingly, the scope of protection of this invention is limited only by the following claims and their equivalents.

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